ÖGH Herpetozoa
Austrian Herpetological Society

Herpetozoa 37: 77–84 (2024)
DOI 10.3897/herpetozoa.37.e112716

Kleptoparasitism in *Micrurus mipartitus* (Squamata, Elapidae) competing for the same *Caecilia* sp. (Gymnophiona, Caeciliidae) in western Colombia

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https://zoobank.org/6ECAFBF8-CE79-49B4-AF1F-EA25D45FFE09

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Academic editor: Günter Gollmann ♦ **Received** 19 September 2023 ♦ **Accepted** 8 March 2024 ♦ **Published** 22 March 2024

Abstract

Kleptoparasitism, or food theft, is seldom reported in wild populations of snakes. Here, we describe as case where two Red-tailed Coral Snakes, *Micrurus mipartitus*, were observed competing for the same caecilian prey, either *Caecilia leucocephala* or *C. perdita*. This took place at night in a rainforest habitat in Valle del Cauca Department, western Colombia. Upon our arrival, the battle had already started as the two coral snakes kept bite-holds on the caecilian. They continued biting the prey at different places on the anterior parts and tugging in opposite directions. The snakes also made rotations along the longitudinal axis as they maintained their bite-holds. Surprisingly, one snake also bit the body of the other snake once. After 17 minutes of observation, the losing coral snake released its bite-hold on the caecilian. The winner then moved away from the losing snake which did not follow. It is well-known that *M. mipartitus* and other coral snakes eat caecilians, but this is the first observation of kleptoparasitism in elapid snakes in the wild. It is considered likely that they rely on chemoreception when detecting caecilians, notably in this case as two coral snakes detected the same prey item. In general, kleptoparasitism may occur more frequently amongst snakes than indicated by the very few published cases considering that numerous cases from captivity are known.

Key Words

caecilian, chemoreception, combat for food, coral snake, odour, resistance, scent, theft, Valle del Cauca, venom

Introduction

Kleptoparasitism is a feeding strategy defined as intraspecific or interspecific, deliberate stealing of already procured food (Broom and Ruxton 1998). It is known in a wide array of animals (Iyengar 2008) and is particularly conspicuous and well-described in birds (Brockmann and Barnard 1979) and in many invertebrates (Vollrath 1984). Iyengar's (2008) review includes some examples in lizards and turtles, but none amongst snakes. Kleptoparasitism is seldom reported in crocodiles, but is suspected to be widespread and hitherto overlooked (Platt et al. 2007).

The Red-tailed Coral Snake, *Micrurus mipartitus* (Duméril, Bibron & Duméril, 1854), is a widespread elapid species in Colombia (mainly the western half), but its overall distribution includes adjacent countries in South America and eastern Panama (Köhler 2008; Rios-Soto et al. 2018). This species is bicoloured with black body rings alternating with white, cream or yellow rings, but the parietal and caudal rings are red-orange and its total length is normally 60–75 cm, but rarely up to 120 cm (Campbell and Lamar 1989; Rios-Soto et al. 2018). The black rings may have a brown tinge as seen in one of the individuals in this paper. The pattern is variable and five subspecies are recognised, four of which occur in Colombia,

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namely the nominate subspecies, *anomalus*, *decussatus* and *popayanensis*, whereas *semipartitus* is extralimital and is distributed in northern Venezuela (Roze 1996). The nominate subspecies is known from the Pacific area of Colombia (including the San Cipriano area and Valle del Cauca, in general), as well as eastern Panama.

In this paper, we describe a rare event as two *M. mipartitus mipartitus* were observed in a vigorous dispute for the same caecilian prey in western Colombia. This is a new observation of kleptoparasitism which has not been documented in coral snakes or any other elapids in the wild before.

Observations

On 10 March 2023, two adult *Micrurus mipartitus* (estimated total lengths 55–70 cm) competing for an adult caecilian (estimated total length 25–40 cm) were observed in the Reserva Natural San Cipriano, Valle del Cauca Department, western Colombia. Coordinates: 3°49'51"N, 76°53'16"W; altitude 106 m a.s.l. The habitat consisted of a dirt road in the rainforest. Upon our arrival at 20:52 h, we witnessed that the two coral snakes kept bite-holds on the caecilian. None of the three individuals was handled or otherwise touched during the combat and feeding event. The following observations have been based on photographic and video documentation taken by Henrik Bringsøe and Niels Poul Dreyer. The observations were made by the authors, Alejandro Grajales and a local guide.

In this report, the term "winner" is used for the coral snake which eventually kept and carried away the caecilian, whereas "loser" is used for the snake eventually losing the caecilian. The two coral snakes could be distinguished from their different patterns and colourations being conspicuous in photos and video sequences. After the winner had moved away with its caecilian prey, the loser was photographed and unique characters were observed (Fig. 5) and then comparisons between the two snakes in an earlier close-up picture were made (Fig. 3). The ground colour of the winner appeared brownish-black, whereas that of the loser was black and the winner appeared larger than the loser. Furthermore, marked differences in the pattern in the right side of the red-orange parietal ring of the two individuals were recorded as follows:

The loser: Just behind the right eye, a fine black streak in the border between two head scales reached into the red-orange area. Moreover, the demarcation between the anterior part of the red-orange parietal ring and the posterior part of the black head colouration in the labial region was highly irregular, but sharp. The demarcation between the posterior part of the red-orange ring and the adjacent black area was also irregular because two fine black streaks penetrated into the red-orange area; a black chevron-shaped marking appeared between these two streaks.

The winner: Behind the right eye, a black streak was absent. The demarcation between the anterior part of the red-orange parietal ring and the posterior part of the black head colouration appeared blurred and small poorly-defined brownish spots were present in the posterior part of the red-orange ring, but there were no conspicuous irregularities in the posterior demarcation of the red-orange ring.

From the beginning, we observed both snakes being active and energetic biting the caecilian and tugging at it in opposite directions. That implies that the event must have started before our arrival at 20:52 h. Generally, they made their bite-holds on the anterior parts of the caecilian, close to its head (Figs 1–3). From 20:54 h, rotations along the longitudinal axis were performed by the snakes as they maintained their bite-holds, but mostly made clockwise by the loser (Suppl. material 1, 2).

From 20:56 h, mucous, probably produced by the caecilian, was noticed on the caecilian around the places of the snakes' bite-holds (Fig. 3).

At 20:58–21:01 h, the loser kept a bite-hold on the caecilian's body, while the winner constantly and eagerly moved along the loser's and the caecilian's bodies. The loser, while trying to secure bite-holds on the caecilian, often reacted with rapid jerks when its head was touched by that of the winner (Suppl. material 3).

From 21:06 h, the winner got a bite-hold on the caecilian's head and at 21:07 h, the loser moved its bite-hold to the central part of the caecilian's body.

At 21:08–21:09 h, the loser and the caecilian appeared entwined, while the winner continued biting the caecilian.

At 21:09 h, the loser bit the body of the winning snake, while the winner maintained its bite-hold on the caecilian's head (Fig. 4). The duration of one snake's bite-hold on the other snake was approx. 30 seconds. A bit later at 21:09 h, the loser released its bite-hold on the caecilian and subsequently the winner carried the caecilian into the vegetation and moved away from the loser which did not try to follow.

At 21:26 h, the loser was photographed alone which made it possible to register morphological characteristics (Fig. 5) in comparison with the winner.

In neither of the described events did the caecilian attempt to bite the two snakes in defence.

Discussion

Our observation involving two individuals of *M. mipartitus* competing for the caecilian is the first published case of kleptoparasitism in the family Elapidae in the wild. Since we did not touch any of the three animals involved, precise identification of the caecilian is difficult, considering that the most reliable way to identify caecilians is by groove counts, but it is a member of the genus *Caecilia* which is represented by five species in the Pacific lowlands of Colombia (Fernández-Roldán and Lynch 2023). Of these, only *C. leucocephala* and *C. perdita* have light-coloured heads in contrast to the dark body, but *C. perdita* (< 50 cm total length) attains larger sizes than *C. leucocephala* (< 30 cm total length) which implies that it is uncertain whether this caecilian belongs to either *C. leucocephala* or *C. perdita* (Fernández-Roldán, pers. comm. 2023).

Figure 1. Overview of the two *Micrurus mipartitus* competing for a caecilian, *Caecilia* sp., on a dirt road in the rainforest at night. Both coral snakes kept bite-holds on the anterior parts of the caecilian's body. Here, the loser with black ground colour is most conspicuous because its head is fully visible. 10 March 2023 at 20:53 h. Photo HB.

Figure 2. During the bite-holds, the two *Micrurus mipartitus* were tugging in opposite directions. The loser to the left, the winner to the right. 10 March 2023 at 20:56 h. Photo HB.

Figure 3. Mucous, probably produced by the caecilian, appeared on the caecilian around the places of the snakes' bite-holds. The winner to the left, the loser to the right. 10 March 2023 at 20:56 h. Photo HB.

Figure 4. One coral snake (the loser) was biting the body of the winning snake which shortly later moved away from the losing snake with its caecilian prey. 10 March 2023 at 21:09 h. Photo NPD.

Figure 5. The losing *Micrurus mipartitus* photographed some minutes after the winner had moved away with its prey. The pattern of the right side of the red-orange parietal ring exhibited unique characteristics in comparison with the same area of the winner (see the text for details). 10 March 2023 at 21:26 h. Photo HB.

The diet of coral snakes of the genus *Micrurus* is known to consist largely of elongate prey, such as snakes, amphisbaenians, lizards, caecilians and, to a lesser extent, fishes, notably eels (Roze 1982; Banci et al. 2017; Fernández-Roldán and Gómez-Sánchez 2021). Generally speaking, that also applies to the diet of *M. mipartitus* which is known to prey on snakes, amphisbaenians, lizards, caecilians (including *Caecilia* spp.) and frogs (Rios-Soto et al. 2018; Fernández-Roldán et al. 2021). However, predation events by *Micrurus* spp. in the wild are seldom observed (Maffei et al. 2009; Banci et al. 2017).

Fernández-Roldán and Gómez-Sánchez (2021) briefly reviewed toxins produced by New World caecilians against predators. Additionally, new research indicates that Latin American caecilians, including the genus *Caecilia*, have evolved resistance to neurotoxins of *Micrurus* and other elapid snakes (Mancuso et al. 2023). That may explain why the caecilian in this case appeared unaffected by the numerous bite-holds of the two coral snakes during the 17 minutes we watched the event. Several cases support that coral snakes are specialised feeders on elongate or vermiform prey (Fernández-Roldán and Gómez-Sánchez 2021) and such predator-prey relationships usually work as evolutionary arms-races escalating adaptations and counter-adaptations against each other. Caecilians' toxins, resistance to neurotoxins and increased production of mucus making them slippery may serve as anti-predatory responses to attacks of coral snakes. However, other cases of coral snakes preying on caecilians resulted in the weakening or death of the prey within the first minutes to an hour (Viana and Mendes 2015; Fernández-Roldán and Gómez-Sánchez 2021), which may suggest that neurotoxic resistance is not widespread, contrary to the reports of Mancuso et al. (2023). In the important study by Jorge da Silva and Aird (2001), it was concluded that prey are more susceptible to venoms of *Micrurus* species that feed upon them than to venoms of those that eat other animals. Thus, further research on neurotoxic resistance will be required, perhaps even including the sampling of several populations within widespread species.

Another factor impacting the effect of coral snake venom on its prey is the amount of venom injected implying that caecilians injected with very small quantities of venom may potentially suffer less. In a recent study of venom production in nine Mexican species of *Micrurus*, tremendously diverse yields were recorded ranging from 0.3 mg to 59 mg per extraction (Neri-Castro et al. 2024). To some extent, this variability was explained by snake lengths, but it was suggested that other important factors also influenced the amount of obtained venom. The extractions were conducted by inducing the snakes to bite plastic spoons covered with Parafilm and pressure to the venom glands was not applied. It is an open question whether smaller yield fluctuations might have been

achieved if the snakes' venom glands had been exposed to pressure. The determinants of the quantity of venom either injected voluntarily or expressed manually remain relatively poorly studied (Wüster, pers. comm. 2024). In a literature review of venom yields of Brazilian *Micrurus* spp., the fluctuations were generally smaller (Carvalho et al. 2014). To our knowledge, venom production of *Micrurus mipartitus* has not been studied.

Repeatedly, each of the two coral snakes performed rotations about their own longitudinal body axis as they had secured bite-holds on the caecilian. This element of feeding behaviour is seldom observed in snakes, but previously reported in another species of coral snake preying upon a caecilian (Fernández-Roldán and Gómez-Sánchez 2021). Such rotations about the longitudinal body axis may also be called "death rolls"; however, that spinning manoeuvre is usually used for rapid rotations to tear off limbs or meat and is typically seen in crocodiles (Fish et al. 2007; Drumheller et al. 2019). In this case, on the contrary, the rotations were slow and were apparently a sequence of movements to untwist or unknot the caecilian.

It is noteworthy that one of the coral snakes bit the body of the other snake for approx. 30 seconds at the end of the battle. During the event, we used our lamps which may have blinded the snakes temporarily. Often the snakes were entwined with the caecilian which, in turn, produced mucous which was transferred to the snakes. Thus, the caecilian's odour particles probably covered much of the snakes' surfaces. Since it has been suggested that coral snakes often rely on chemosensory prey detection rather than vision when foraging (Marques et al. 2017), we believe it was an accident that one coral snake bit the body of the other, confusing it with the caecilian, though it cannot be ruled out that one coral snake might have attempted to prey on the other coral snake considering that cannibalism in *Micrurus* spp. has already been reported in literature. Apparently, the bitten snake was not affected by the bite.

Kleptoparasitism in snakes has not been paid much attention. Several cases in captivity are known (Naulleau 1967; Kelleway 1982; Burghardt and Denny 1983; Grimpe 1984; Yeager and Burghardt 1991; Firmage and Shine 1996; Doody et al. 2021), but few are reported in the wild. These events in the wild may involve multiple individuals of the same species (Platt et al. 2018), competitions associated along with ritualised combats (*Agkistrodon conanti*, Farrell 2022, pers. comm. 2023) and interspecific interactions, either including other congeners (Platt et al. 2020) or lizards (McConchie and Wilkinson 2004). Greene (in Iyengar 2008) suggested that the likelihood that a feeding snake will be challenged for a food item by another animal was small considering the widely-spaced intervals of feeding in many snakes. It is expected that kleptoparasitism in snakes would be particularly common in places with high population densities, as in the observations made by Platt et al. (2020) and Farrell (2022). Due to its crepuscular and nocturnal habits (Rios-Soto et al. 2018), *M. mipartitus* is rarely seen, albeit easy to detect because of its vivid, characteristic colouration. However, based on our field experience, we consider its populations densities may potentially be low. We consider that both coral snakes may have been attracted by the caecilian odour, as some species of snakes have been reported to trace back scents from hundreds of metres or even more than two kilometres (e.g., Brown and MacLean 1983; Andrén 1986). A coral snake pulling a caecilian out of the ground, after allegedly having detected it by chemoreception, has even been reported (Fernández-Roldán and Gómez-Sánchez 2021).

Kleptoparasitism amongst snakes in captivity has been known for decades and probably even centuries and basic warnings of not feeding two snakes one prey item have been communicated in a wide variety of books on herpetoculture including beginners' guides that even warn keepers that larger snakes may swallow the smaller (e.g., Klingelhöffer 1959; Roberts 1975; Frank 1979; Trutnau 1994). Albeit rarely reported, it is probable that kleptoparasitism may occur more frequently amongst wild snakes than previously thought.

Acknowledgements

Juan David Fernández-Roldán (Universidad Nacional de Colombia, Bogotá) provided valuable information as he tried to identify the caecilian prey in this study. Thanks to Terence M. Farrell (Stetson University, DeLand, Florida) for inspiring discussions about kleptoparasitism and to Wolfgang Wüster (Bangor University, UK) for useful hints on snake venom and resistance to venom. Alejandro Grajales (Armenia, Colombia) and Leonilda Viera (Nuquí, Colombia) arranged our excellent journey in western Colombia in March 2023. Mark Hanger (Copenhagen, Denmark) made valuable contributions and reviewed the English language.

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Supplementary material 1

Video A1

Authors: Henrik Bringsøe, Niels Poul Dreyer

Data type: mp4

Explanation note: Two *Micrurus mipartitus* in a competition for the same caecilian prey. Both snakes were biting the anterior part of the caecilian and tugging in opposite directions. Initially, the distance between them was 1½–2 times the diameter of the caecilian. However, the winning snake moved its bite-hold closer to the loser so that the two snakes' snouts and/or chins eventually touched each other. As they touched, the loser completed a clockwise rotation around its longitudinal body axis. Reserva Natural San Cipriano, Valle del Cauca, Colombia.10 March 2023 at 20:57 h. Duration: 24 seconds. Recorded by NPD.

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Link: https://doi.org/10.3897/herpetozoa.37.e112716.suppl1

Supplementary material 2

Video A2

Authors: Henrik Bringsøe, Niels Poul Dreyer

Data type: mp4

Explanation note: Two *Micrurus mipartitus* in competition for the same caecilian prey. Solely, the loser had a bite-hold on the caecilian and made 3½ clockwise rotations, while the winner eagerly followed them and kept close physical contact. Reserva Natural San Cipriano, Valle del Cauca, Colombia.10 March 2023 at 20:58 h. Duration: 22 seconds. Recorded by NPD.

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Supplementary material 3

Video A3

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Data type: mp4

Explanation note: Two *Micrurus mipartitus* in competition for the same caecilian prey. The loser maintained a bite-hold in the caecilian's neck region, while the winner moved actively around close to the loser and the caecilian. Notice the rapid jerks performed by the loser when its head was touched by that of the winner. Reserva Natural San Cipriano, Valle del Cauca, Colombia.10 March 2023 at 21:01 h. Duration: 97 seconds. Recorded by HB.

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Link: https://doi.org/10.3897/herpetozoa.37.e112716.suppl3